


Hypertension continuum of care: Blood pressure screening, diagnosis, treatment, and control in a population-based cohort in Haiti

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Abstract

Cardiovascular disease (CVD) is the number one cause of death in low-income countries including Haiti, with hypertension (HTN) being the leading risk factor. This study aims to identify gaps in the HTN continuum of screening, diagnosis, treatment, and blood pressure (BP) control. Sociodemographic and clinical data were collected from a population-based sample of adults ≥ 18 years in Port-au-Prince (PAP) from March 2019 to April 2021. HTN was defined as systolic BP ≥ 140 mmHg, diastolic BP ≥ 90 mmHg, or use of antihypertensive medication. Screening was defined as ever having had a BP measurement; diagnosis as previously being informed of a HTN diagnosis; treatment as having taken antihypertensives in the past 2 weeks; and controlled as taking antihypertensives and having BP $< 140/90$ mmHg. Factors associated with attaining each step in the continuum were assessed using Poisson multivariable regressions. Among 2737 participants, 810 (29% age-standardized) had HTN, of whom 97% had been screened, 72% diagnosed, 45% treated, and 13% controlled. There were no significant differences across age groups or sex. Obesity (BMI ≥ 30) was a significant factor associated with receiving treatment compared to normal weight (BMI < 25), with a prevalence ratio (PR) of 1.5 (95% CI 1.1–2.0). Having secondary or higher education was associated with higher likelihood of controlled BP (PR 1.9 [95% CI 1.1–3.3]). In this urban Haitian population, the greatest gaps in HTN care are treatment and control. Targeted interventions are needed to improve these steps, including broader access to affordable treatment, timely distribution of medications, and patient adherence to HTN medication.

KEYWORDS

cardiovascular disease, continuum of care, Haiti, hypertension

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1 | INTRODUCTION

Non-communicable diseases (NCDs) such as cardiovascular disease (CVD) are the leading cause of morbidity and mortality globally and are increasing rapidly in low- and middle-income countries (LMICs).^{1,2} Hypertension (HTN) is the most prevalent risk factor for CVD in LMICs,^{3,4} with increased BP resulting in life expectancy reductions of 2.6 years for men and 2.9 years for women.^{5,6} High systolic blood pressure (SBP) accounted for 10.4 million deaths and 235 million DALYs in 2019 with two-thirds of the burden occurring in LMICs.⁷ Lowering BP has been shown to substantially reduce CVD mortality and morbidity^{3,4}; however, a large proportion of individuals living in LMICs lack access to HTN screening and management⁸; LMICs have approximately half the proportion of awareness and treatment and a quarter of the control rate, compared to high-income countries.⁹

In Haiti, HTN is the leading CVD risk factor, with an age adjusted prevalence of 28.5%,^{10,11} and estimates as high as 49% in women and 40% in men ages 35–64.¹² Additionally, HTN may occur earlier in Haitians, with HTN among Haitians aged 18–30 years being two to four times higher than similarly aged Black Americans.¹³ Higher BP in Haitians may in part be due to environmental stressors such as earthquakes and other natural disasters, which put additional strain on the healthcare system.¹⁴ HTN management is a growing challenge in Haiti due to limited access to primary care services, economic constraints, and poor public health infrastructure, with cost of medications an important barrier.^{5,15,16}

NCD care continua are theoretical frameworks used to monitor public health system performance by measuring steps of screening, diagnosis, treatment, and ultimately control of chronic diseases.^{17,18} They are useful to benchmark the coverage or unmet need of primary and secondary prevention interventions for BP in a community. While population level estimates of HTN for Haiti have been reported in the 2016–2017 Demographic Health Survey (DHS), the survey focuses only on adults 35–64 and may not be representative of the wider population. We present a population-based study with research-grade BP measurements to describe the HTN care continuum in Port-au-Prince (PAP) to identify areas of need for HTN management in this underserved population.

The goal of this analysis was to (1) quantify HTN prevalence and the rates of achieving each step of the care continuum and (2) determine the factors associated with attaining HTN diagnosis, treatment, and control, in a population-based sample from urban Haiti.

2 | METHODS

2.1 | Study design and population

This analysis includes baseline cross-sectional data from participants enrolled in the Haiti CVD Cohort Study, a longitudinal observational study of adults ≥ 18 years in PAP.¹⁹ The study was conducted at the Groupe Haitien d'Etude de Sarcome de Kaposi et de Infections Opportunistes (GHESKIO), a research, treatment, and training clinic located

in downtown PAP. The aims of the parent study are to estimate the prevalence and incidence of CVD risk factors and examine the role of poverty-related social determinants. Participants were recruited using multistage random sampling from metropolitan PAP which includes an estimated 1.4 million people.²⁰

For this analysis, we included participants enrolled from March 19, 2019, to April 30, 2021. The analysis was restricted to participants with information on sex, SBP, diastolic blood pressure (DBP), and responses to questions regarding previous diagnosis of HTN and use of antihypertensives (Figure S1).

2.2 | Measurements

Sociodemographic data (age, sex, education, income), health behaviors (smoking status, physical activity) and clinical data (height, weight, SBP, DBP) were collected at time of study enrollment at GHESKIO. Education was categorized as having completed no education, primary, secondary, or higher than secondary school. Income was categorized from self-reported data as ≤ 1 USD per day or > 1 USD per day.^{11,21} Self-reported smoking status was categorized as never smokers or current/former smokers. Physical activity was determined using questions about vigorous activity for longer than 75 min per week, or moderate activity for longer than 150 min per week. Participants were categorized as low physical activity (no to both questions) versus moderate to high physical activity (yes to either question). Participants were categorized into groups based on WHO guidelines for BMI, where less than 18.5 kg/m² was underweight, 18.5–25 kg/m² was normal weight, 25–30 kg/m² was overweight, and over 30 kg/m² was obese.²²

BP was measured by study staff following WHO and AHA guidelines.^{23,24} The OMRON HEM907 automatic BP machine was used to measure BP with appropriate cuff sizes that encircled at least 80% of the arm. Participants were seated for 5 min prior to measurement, with both feet on the ground and arms at heart level. Three measurements were taken in the left arm 1 min apart. For this analysis, BP was determined by averaging the last two of three BP measurements.^{22,25} HTN was defined as SBP ≥ 140 mmHg, DBP ≥ 90 mmHg, or the use of self-reported antihypertensive medication.

2.3 | Care continuum

The HTN care continuum was constructed by categorizing adults with HTN into sequential steps based on self-reported data. History of screening was defined as participant ever having their BP measured prior to study enrollment. HTN diagnosis was defined as a participant having been previously diagnosed with HTN. Treatment was defined as taking any antihypertensive medications in the last two weeks including a thiazide (hydrochlorothiazide), calcium channel blocker (amlodipine, nifedipine), beta blocker (atenolol), angiotensin converting enzyme (ACE) inhibitor (captopril, lisinopril, enalapril), angiotensin II receptor blocker (ARB) (telmisartan, losartan) and alpha II agonist (methylodopa).

Finally, control was defined as having a SBP < 140 and DBP < 90 mmHg and taking antihypertensives.

2.4 | Statistical analysis

Descriptive statistics were generated using means for continuous variables and proportions for categorical variables. We calculated the rates of diagnosis, treatment, and control among those with HTN. Cumulative proportions were calculated by dividing the number of participants at each step of the cascade by the total number of hypertensive participants ($n = 810$). Conditional proportions were calculated using the number of participants that reached the previous step of the cascade as the denominator. Age-standardized HTN prevalence was calculated using direct standardization with the WHO standard population data for 2000–2025.²⁶

We used Poisson regressions to investigate health behavior and sociodemographic factors associated with HTN management. Diagnosis, treatment, and control were used separately as dichotomous outcome variables for three Poisson regression models. Poisson regressions were used rather than logistic regressions due to the high likelihood of events, as logistic regressions would result in odds ratios very different from risk ratios.²⁷ For each model, the covariates used were age category, sex, BMI category (normal/underweight, overweight, obese), education level (none, primary, secondary/higher), income (>1 USD or ≤1 USD), smoking status (never or current/former), and physical activity (>150 min/week or ≤150 min/week). Robust standard errors were used for all regression models.

All analyses were performed using R statistical software, version 1.2.5019.

2.5 | Ethics approval and consent to participate

The study protocol and ethical consent forms were approved by Weill Cornell Medicine and GHEKIO. Individuals selected for the study provided written informed consent prior to enrollment.

3 | RESULTS

Among 2737 adults included in this analysis, median age was 41 years (IQR 28–56), and 60% were female (Table 1). Thirty-six percent of participants had primary or no education. The majority of participants (69%) earned less than \$1 USD per day. Twenty-seven percent of participants were overweight and 18% obese. The rate of smoking was 8% and 50% had low physical activity <150 min/week.

A total of 810 participants had HTN (30.0% crude prevalence, 28.7% age-standardized prevalence). Among people with HTN, the median age was 55 years (IQR 47–63), and 64% were female (Table 1). Age and sex characteristics were similar among participants with HTN compared to participants in the overall study population. However, a higher proportion of participants with HTN had no education or only primary

schooling. Among those with HTN, the median SBP was 150 mmHg (IQR 143–166) for males and 149 mmHg (IQR 140–162) for females. The median DBP for those with HTN was 91 mmHg (IQR 83–98) for males and 91 mmHg (IQR 82–99) for females. A third (30.9%) of those with HTN, had stage II HTN defined as SBP ≥ 160 or DBP ≥ 110. Hypertensive participants on treatment ($n = 362$) had a median SBP of 150 (IQR 134–164) and DBP 88 (IQR 78–99).

3.1 | Hypertension care continuum

The HTN care continuum results are displayed in Figure 1, with cumulative and conditional proportions described below. Among those with HTN ($N = 810$), 785 (97%) participants reported being screened, 581 (72%) diagnosed, 362 (45% treated), and 106 (13%) were controlled.

Among the 362 individuals on antihypertensive medication, 47% (170/362) reported taking a thiazide, 29% (104/361) a calcium channel blocker, 31% (114/362) an ACE inhibitor, 6% (22/362) a beta blocker, 1% (4/362) ARB, and <1% (1/362) an alpha II agonist. Twenty-eight percent of patients on treatment (101/362) reported use of two or more antihypertensive medications. Participants taking amlodipine were less likely to have controlled HTN compared to those taking other antihypertensives ($p = .004$).

Analysis of the conditional proportions of attaining each step of the care continuum revealed that the greatest drop-off across steps was at the level of control, where only 29% (106/362) of those treated had controlled BP (Figure 2).

Figure 3 reports the HTN care continuum by sex and Figure 4 by age categories. Sex was not a significant factor in the bivariate regression models (Table 2), although males had slightly lower attainment at each level of the care continuum. Individuals in the 18–29 age category had the lowest prevalence of HTN overall (3%), while individuals over 60 had the highest prevalence (67%). There was a trend of increasing HTN

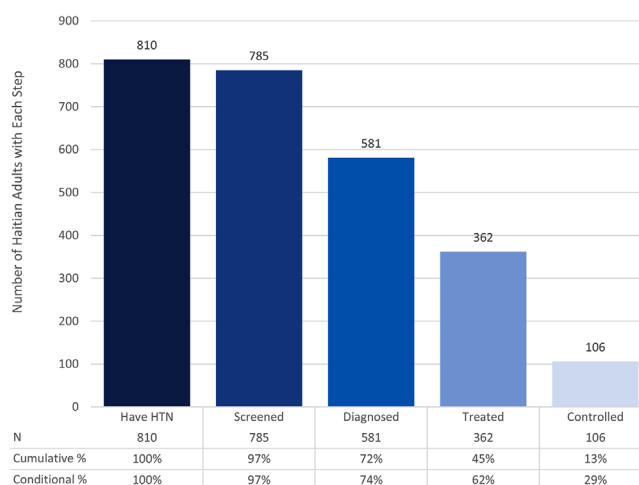


FIGURE 1 Hypertension care continuum for Haitian adults in the Haiti CVD cohort. Percentage of participants who have been screened, diagnosed, treated, and controlled among all individuals with HTN ($N = 810$)

TABLE 1 Sociodemographic and clinical characteristics for Haitian adults in the Haiti CVD cohort

	Total participants N (%)	Participants with hypertension N (%)
Total sample	2737	810 (30%)
Age, years		
Median (IQR); range	41 (28–56); (18–93)	55 (47–63); (19–93)
18–29	795 (29%)	21 (3%)
30–39	517 (19%)	70 (9%)
40–49	482 (18%)	157 (19%)
50–59	456 (17%)	237 (29%)
60+	487 (18%)	325 (40%)
Sex		
Female	1653 (60%)	516 (64%)
Male	1084 (40%)	294 (36%)
Education		
None	393 (14%)	225 (28%)
Primary	593 (22%)	288 (36%)
Secondary	1350 (49%)	267 (33%)
Higher than secondary	394 (14%)	29 (4%)
Missing	7 (<1%)	1 (<1%)
Income (daily)		
≤1 \$ USD	1889 (69%)	568 (70%)
>1 \$USD	841 (31%)	241 (30%)
Missing	7 (<1%)	1 (<1.0%)
BMI (kg/m ²)		
Median (IQR)	24.7 (21.4–28.8)	26.3 (22.6–30.6)
Underweight/Normal <24.99	1526 (56%)	344 (42%)
Overweight 25.0–29.9	730 (27%)	264 (33%)
Obese >30.0	481 (18%)	202 (25%)
Smoking status		
Never	2506 (92%)	755 (93%)
Current/Former	221 (8%)	53 (7%)
Missing	10 (<1%)	2 (<1%)
Physical activity		
≤150 min/week (low)	1369 (50%)	469 (58%)
>150 min/week (moderate-high)	1357 (50%)	337 (42%)
Missing	11 (<1%)	4 (<1.0%)

diagnosis with increasing age (Figure 3) and being 60 years or older was a significant factor associated with HTN diagnosis (PR 2.3, 95% CI 1.1–4.9) (Table 2).

3.2 | Multivariable regressions for hypertension care continuum outcomes

In multivariable Poisson regressions for diagnosis, treatment, and controlled HTN, few sociodemographic factors were predictive of the

outcomes (Table 2). Obesity was the only significant factor associated with treatment (PR 1.5, 95% CI 1.1–2.0), and having a secondary or higher education was associated with controlled HTN (PR 1.9, 95% CI 1.1–3.3).

4 | DISCUSSION

In this population-based cohort of Haitian adults, the age-standardized prevalence of HTN was 29%. This is similar to the HTN prevalence

	Screening	Diagnosis	Treatment	Control
Total with HTN (N=437)	96.8%	76.4%	68.1%	31.4%
By Sex				
Male (N=121)	95.0%	76.5%	62.5%	30.9%
Female (N=316)	97.5%	76.3%	70.2%	31.5%
By Age Group (years)				
18-29 (N=15)	93.3%	57.1%	75.0%	83.3%
30-39 (N=30)	90.0%	59.3%	56.3%	33.3%
40-49 (N=88)	95.5%	70.2%	61.0%	36.1%
50-59 (N=132)	97.7%	78.3%	65.3%	34.8%
60+ (N=172)	98.3%	82.2%	74.1%	24.3%

■ >90%	■ 70-90%	■ 50-70%	■ <50%
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FIGURE 2 Conditional proportions of attaining each step in the hypertension care continuum among Haitian adults with hypertension (N = 810)

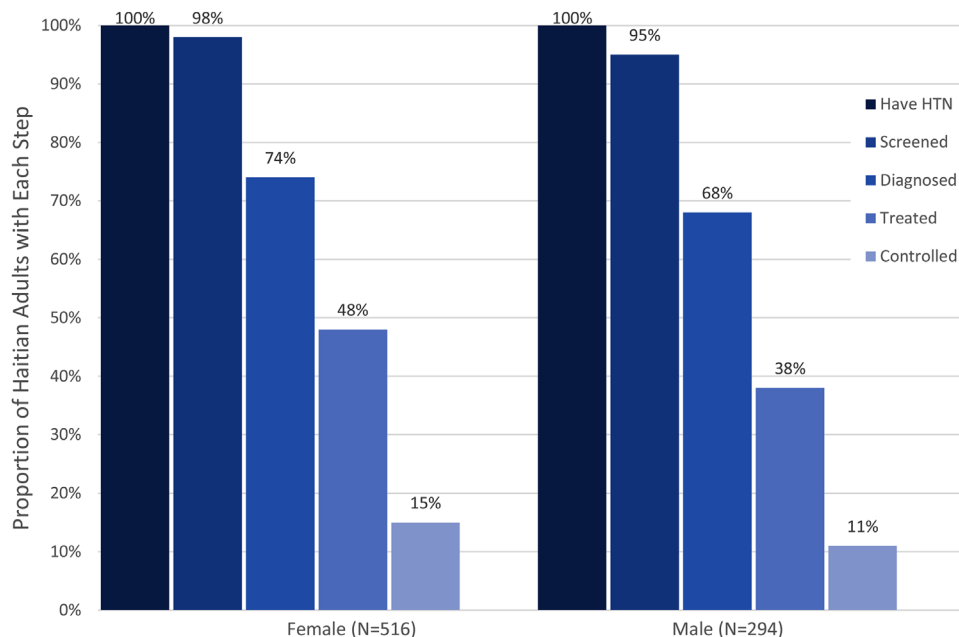


FIGURE 3 Cumulative hypertension care continuum by sex. Percentage of female (N = 516) and male (N = 294) participants with hypertension who have been screened, diagnosed, treated, and controlled

across LMICs globally, which in 2019 was estimated to be 32% in women and 34% in men aged 30–79.²⁸ History of any BP screening was remarkably high (97%) in contrast to very low rates of HTN treatment and control, at 45% and 13% of all patients with HTN, respectively. These data underscore the importance of all steps in the cascade being met for optimal BP control, as HTN is the leading CVD risk factor in Haiti.

Attainment of multiple steps in the HTN care continuum was higher in our cohort compared to national estimates from the 2016 to 2017

Haiti DHS. In our study, BP screening was 97% among those with HTN. The DHS reported rates of BP screening at 85% among women and 61% among men; however, this reflects the general population rather than only those with HTN.¹² High rates of screening found in our study may be due to the participants' proximity to healthcare facilities in the urban setting, as well as increased public awareness about HTN over time. Our data also likely reflect access to community-based BP screening in PAP by GHESKIO, which began in 2016. GHESKIO has trained a cadre of community health workers to use electronic

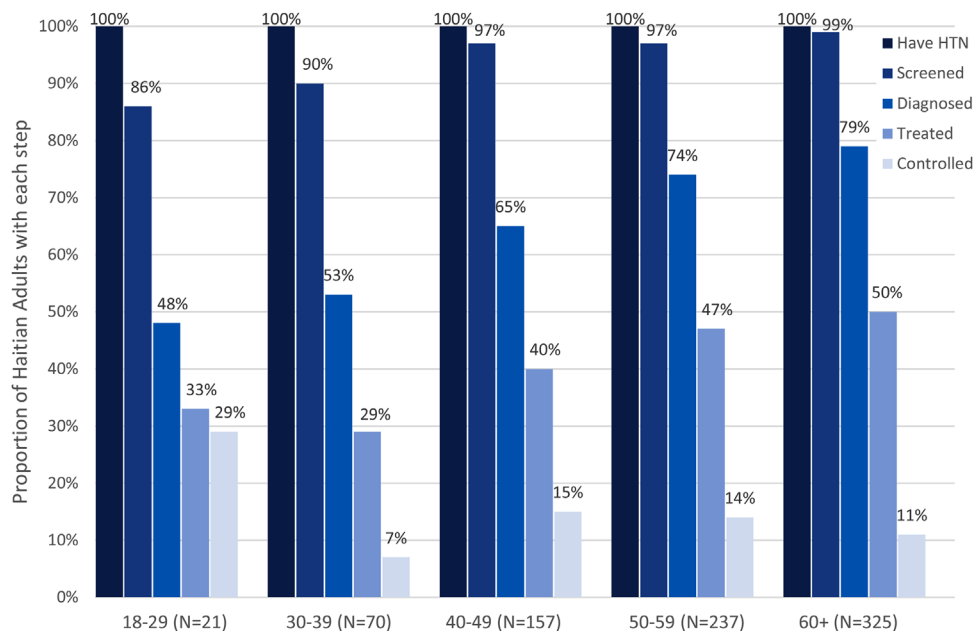


FIGURE 4 Cumulative hypertension care continuum by age category. Percentage of participants with hypertension ($N = 810$) who have been screened, diagnosed, treated, and controlled by age category

sphygmomanometers for BP measurement in individuals homes and communities, coupled with BP counseling across neighborhoods in downtown PAP.¹¹

Our study also had higher rates of HTN diagnosis and treatment than prior studies in Haiti. In our study, 72% of the population had been previously diagnosed with HTN, and 45% were on treatment. In a pilot study conducted in four surrounding neighborhoods of GHESKIO in 2016, we found 44% of women and 36% of men had been previously diagnosed, and only 12% of women and 4% of men reported taking anti-hypertensive treatment.¹² The DHS reported 73% of women and 62% of men had been previously diagnosed, and 26% of women and 22% of men taking anti-hypertensive treatment. Since 2018, GHESKIO has provided free HTN care among those who screened for elevated BP in community screening programs. Reducing the barriers to HTN management is especially important for vulnerable populations with limited access to care. Two vulnerable patient populations in Haiti include pregnant women and persons living with HIV, as HTN during pregnancy is associated with adverse maternal and perinatal health outcomes and increased mortality among persons living with HIV.^{21,29}

Among participants with HTN in our study, only 13% had controlled BP. As with other chronic diseases such as HIV that have shifted toward a full spectrum of community-based screening and management, it may be possible to further strengthen community-based models of HTN management and improve rates of BP control, which vary across LMICs. Analysis of data from 1.1 million individuals across 44 LMICs from 2005 to 2016 reported that 10.3% of the 192 441 individuals with HTN had their BP controlled.³⁰ The control rate was estimated to be 13.7% in seven communities across East and West Africa, 42.5% in a cross-sectional study in South Africa, and 28.8% in a nationally representative survey in India.^{31,32} In a cross-sectional study of urban and rural communities across Latin America, the control rate

was 34%, despite over 90% of participants being aware of their HTN diagnosis.³³ Haiti's 2016–2017 DHS survey estimated extremely low rates of HTN control, at 3.5% among women and 2.6% among men aged 35–64 years.¹²

Poor control of HTN in Haiti and other LMICs is due to a confluence of multiple barriers at the health system, provider, and individual levels.^{34–37} Health care infrastructure, including affordable and operational primary care clinics in Haiti, is sparse and stocked anti-hypertensive medications and working BP measurement equipment is lacking.^{15,35} Antihypertensive medications are often unaffordable if available.^{5,16} Providers face high workloads and often are not trained in proper BP measurement, with routine BP measurement seen as secondary to responding to acute medical needs.^{11,37} Healthy food is costly and or limited.³⁸ At the individual level, the belief that HTN is an episodic disease is common, with many believing that reduction of stress levels is sufficient for HTN management or that HTN is a natural state and does not need management.^{11,34,39–41} Individuals who do not have a comprehensive understanding of HTN, or the importance of BP control may need further education on the need for long-term medication adherence.^{40,41}

Having completed higher than secondary education was associated with controlled BP. This suggests that in addition to improving medication access, affordability, and adherence, education may be associated with increased knowledge about HTN and/or ability to access health care. Obesity was associated with increased HTN treatment but not control of HTN. Obesity may signal clinicians to increasing screening, diagnosis, and treatment initiation of antihypertensives, or obesity may reflect those with higher BMI have higher access to health care. This is consistent with previous studies which found people who were obese to have higher probability of reaching all steps along the care continuum except for control of HTN.^{30,42,43} There will likely be a greater

TABLE 2 Factors associated with hypertensive adults in Haiti attaining diagnosis, treatment, and control of BP (N = 810)

	Diagnosis (PR [95% CI]) Model 1	Treatment (PR [95% CI]) Model 2	Control (PR [95% CI]) Model 3
Age categories (years)			
18–29	1 (ref)	1 (ref)	1 (ref)
30–39	1.5 [.7–3.5]	.9 [.4–2.1]	.3 [.1–1]*
40–49	1.8 [.9–4.0]	1.2 [.6–2.7]	.7 [.3–1.7]
50–59	2.1 [1–4.6]	1.5 [.7–3.3]	.7 [.3–1.7]
60+	2.3 [1.1–4.9]*	1.7 [.8–3.7]	.6 [.3–1.6]
Sex			
Female	1 (ref)	1 (ref)	1 (ref)
Male	1 [.8–1.2]	1.2 [.9–1.5]	1.5 [.9–2.3]
BMI category (kg/m ²)			
Normal or Underweight (BMI < 25)	1 (ref)	1 (ref)	1 (ref)
Overweight (25 ≤ BMI < 30)	1.1 [.9–1.3]	1.1 [.9–1.4]	1 [.6–1.6]
Obese (BMI ≥ 30)	1.2 [.9–1.5]	1.5 [1.1–2.0]*	1.4 [.8–2.2]
Education			
None	1 (ref)	1 (ref)	1 (ref)
Primary	1.0 [.8–1.2]	1.0 [.8–1.4]	1.0 [0.6–1.6]
Secondary or higher	.9 [.7–1.2]	1.2 [.9–1.7]	1.9 [1.1–3.3]*
Income (Daily)			
>1 USD	1 (ref)	1 (ref)	1 (ref)
≤1 USD	1.1 [.9–1.3]	1.2 [.9–1.5]	1.5 [1–2.5]
Smoking status			
Never	1 (ref)	1 (ref)	1 (ref)
Current/Former	1 [.6–1.6]	.8 [.4–1.6]	.6 [.2–2.6]
Physical Activity			
>150 min/week (high)	1 (ref)	1 (ref)	1 (ref)
≤150 min/week (low)	.9 [.8–1.1]	1.2 [.9–1.4]	1.3 [.9–1.9]

*significant *p*-values < .05.

need for HTN management as obesity prevalence has increased in the Caribbean since 1985.⁴⁴

Among individuals on antihypertensive medication, there was wide variety in the type of antihypertensive medication prescribed. In 2019, GHESKIO worked with the Ministry of Health and other stakeholders to streamline first-line antihypertensive regimens for use in primary care settings using WHO guidelines. GHESKIO chose to implement the WHO recommended regimen of a calcium channel blocker (amlodipine) as the first-line medication with hydrochlorothiazide as an alternative first-line agent.⁴⁵ Amlodipine was selected for its safety, the lack of laboratory monitoring, and its effectiveness in Black populations.^{46–48} Of those taking antihypertensives, 67% were on one of these regimens and 38% were on dual agents. Given the median SBP among those on medications was the same as the median SBP of all hypertensives (150 mmHg), the need for increased dosing and/or dual therapy is likely needed. Globally, individuals treated with combination therapies are significantly more likely to have controlled BP than individuals who are

not on these therapies.⁸ These data underscore the need to increase education and implementation of national HTN guidelines.

Strengths of our study include the use of a population-based sample in a setting that has limited literature on HTN screening, diagnosis, and treatment. The DHS only reports care continuum outcomes in adults aged 35–64, while our study includes all adults 18 and older. Additionally, the Haiti CVD Cohort Study includes many slum areas in downtown PAP which have been traditionally understudied in national surveys given the political instability of these neighborhoods. The study used research-grade BP measurements that are comparable to US and international cohorts which follow WHO and international guidelines.²² A limitation is that our definition of HTN includes averaged BP measurements taken on the same day, which may overestimate the prevalence of HTN in the population as there were not two measurements separated by at least a day.^{23,49} Use of self-reported data on HTN treatment and lack of data on medication adherence and dosage are further limitations. Income measurements were

also self-reported. Additional longitudinal studies are needed to evaluate causality. Our random sampling procedures allow this population-based data to be generalizable to the greater urban area of PAP; however, it may not be generalizable to all of Haiti or other LMICs.

In summary, we report an age standardized HTN prevalence of 29% in this population-based sample of adults in PAP. We found excellent rates of BP screening which likely reflect increased community based HTN screening programs implemented over the past 5 years. Yet, at the same time, very low rates of treatment and effective BP control highlight the ongoing need for scale-up of HTN management, provider training, and patient education.

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CONFLICTS OF INTEREST

None.

AUTHOR CONTRIBUTIONS

MM contributed to data analysis and manuscript writing. JLP contributed to data collection, data interpretation, and paper review. LY contributed to data analysis, data interpretation, and manuscript writing. VR contributed to data interpretation and paper review. SS, SE, and FP contributed to data collection. NR and OT contributed to data interpretation and paper review. RM, MMD, and JWP contributed to data interpretation and paper review. MLM contributed to data interpretation, manuscript writing, and paper review.

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